APPARATUS AND METHOD FOR TRANSMITTING TERRESTRIAL SIGNALS ON A COMMON FREQUENCY WITH SATELLITE TRANSMISSIONS

This application is a continuation of application Ser. No. 08/731,244, filed Oct. 11, 1996, now U.S. Pat. No. 5,761,605.

BACKGROUND OF THE INVENTION

This invention relates to devices and methods for broadcasting and receiving data, including digital television signals and voice signals. More particularly, this invention relates to an apparatus and method for providing terrestrial transmissions simultaneously along with direct broadcast satellite transmissions on a common frequency.

Currently, television signals may be received from a satellite in geosynchronous orbit about the earth. The television signals are transmitted from a terrestrial transmitter to the satellite and then retransmitted from the satellite so that the signals can be received by terrestrial receivers within a certain geographic receiving area within a line of sight of the satellite. In addition to television signals, other types of data may also be transmitted to consumers through satellites in geosynchronous orbit.

Direct broadcast satellite service (DBS) refers to satellite transmission of television signals directly for use by individual households or subscribers having the proper signal receiving equipment. The U.S. Federal Communications Commission has dedicated the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. Numerous signal carriers are located within the DBS spectrum, each carrier carrying several individual television channels. Depending upon the compression technology applied to these signals, literally hundreds of separate channels may be available through DBS. A great benefit of the DBS system as opposed to prior satellite systems is that only a small dish-type antenna is required to receive the DBS signals and the alignment of the receiving dish is not critical. Also, the DBS system will provide high quality reception at any point in the geographic receiving area of a satellite without the expense of land transmission lines such as those required for cable television.

Current regulations require that DBS satellites be separated from each other by at least nine (9) degrees in a geosynchronous arc. The receiving antenna for DBS signals must, therefore, be limited to receiving signals in a directional range measuring plus or minus nine (9) degrees from a centerline of the antenna. Receiving signals in a range wider than the satellite spacing would cause interference by signals transmitted by different satellites on the same frequency.

U.S. Pat. No. 5,483,663 is directed to a system having a receiver arrangement in which DBS and terrestrial signals are received within similar frequency bands. The system shown in the U.S. Pat. No. 5,483,663 may be implemented with a multiple antenna arrangement, or with a single, moveable antenna. In the multiple antenna arrangement, two separate antennas direct the received signals to a common propagation path for processing as if they were received by a single antenna and transmitted from a single location. In the single antenna arrangement, the antenna is movable between a position to receive DBS signals and another position to receive terrestrial signals.

The advantage of the system shown in U.S. Pat. No. 5,483,663 is that local originating signals, whether television signals or other data, may be received simultaneously with DBS signals, and processed with the same equipment as that used to process the DBS signals. The local originating signals may carry local programming which may be received along with the national or regional DBS programming.

However, since the signals received in the system shown in U.S. Pat. No. 5,483,663 are combined or received on the same antenna structure at different points in time, terrestrial and DBS signals on a common frequency cannot be utilized simultaneously.

SUMMARY OF THE INVENTION

It is an object of the invention to provide terrestrially transmitted signals simultaneously with satellite transmitted signals at the same frequency. The invention includes an apparatus and method for providing terrestrial signals simultaneously at a common frequency with satellite signals.

The object of the invention is accomplished by utilizing receiving antennas with a limited directional reception range and transmitting the terrestrial signals in a different range of directions than those in which the satellite signals are transmitted. Two separate receiving antennas feeding two sets of decoding and demodulating processing systems are required for utilizing the received signals. Both receiving antennas are adapted to receive signals only within a particular directional range. The range is measured from a centerline of the particular antenna.

In order to ensure no interference between the satellite and terrestrially transmitted signals, the terrestrial signals are transmitted directionally within a terrestrial azimuth range which is outside the azimuth range in which the satellite signals are transmitted either by a single satellite or multiple satellites. The terrestrial transmission azimuth range is chosen so that it does not include any directions in which the satellite signal receiving antenna must be directed to receive signals from any satellite. In order to cover a large area for local reception, a plurality of terrestrial transmitters are spread out over an area with directional transmission areas overlapping to ensure the terrestrial signals may be received clearly at each location within the desired service area.

These and other objects, advantages, and features of the invention will be apparent from the following description of the preferred embodiments, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation showing the positions of a plurality of satellites in relation to a single terrestrial transmitter and a receiver or user location.

FIG. 2 is a somewhat schematic representation of a receiving antenna structure for receiving satellite and terrestrial transmitted signals at a common frequency.

FIG. 3 is a schematic representation of the spacing for a number of terrestrial transmitters required to allow reception over a large geographic area.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus according to the invention for providing terrestrially transmitted signals simultaneously on the same frequency as satellite signals is illustrated in FIGS. 1 and 2. As shown in FIG. 1, the system **10** may be utilized with one or more satellites in geosynchronous orbit about the earth.

FIG. 1 shows four satellites **12**a, **12**b, **12**c, and **12**d spaced apart at four separate directions from a user location **14**. In geosynchronous orbit, each satellite remains at a fixed location with respect to the earth's surface, and thus, with respect to the user location **14**. First and second antenna **16** and **18**, respectively, which will be discussed in detail with reference to FIG. 2 are located at the user location **14**.

Each of these satellites **12**a–d is positioned in geosynchronous orbit about the center of the earth, and is positioned at a certain longitude and latitude above the earth's surface. As is known by those skilled in the art, a receiving antenna may be directed at a certain elevation and direction or azimuth toward a desired satellite location for receiving signals from the particular satellite.

Currently, all direct broadcast satellites within the line of sight of North America are positioned at longitudes and latitudes requiring the receiving antenna to face in a southerly direction from North America to receive signals. Although FIG. 1 shows four satellites **12**a–d for purposes of describing the invention herein, more or fewer satellites may be spaced apart within a line of sight of a certain geographical area. Several satellites are currently within a line of sight of North America. Table 1 sets out the longitudinal location of each satellite and for purposes of example, the azimuth and elevation at which a receiving antenna must be directed from a location at Austin, Texas for receiving signals from each satellite. All azimuth directions and elevations are measured to a centerline of the antenna which will be discussed below with respect to FIG. 2. The term "azimuth" refers to the direction with respect to a reference direction such as due north, commonly zero degrees. "Elevation" refers to the angle of the antenna centerline above horizontal.

TABLE 1

Satellite Longitude	Azimuth	Elevation
61.5	124.5	37.3
101	186.4	54.[illegible]
110	203.3	52.3
119	217.7	47.8
148	247.3	25.7
157	253.3	17.[illegible]
166	258.8	10.[illegible]
175	263.5	2.3

DBS satellites all transmit different signals in the same frequency band. The U.S. Federal Communications Commission has set aside the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. In order to ensure no interference from signals between two adjacent satellites, two conditions must be met. First, the receiving antenna must be limited to receive signals only within a certain reception range about the centerline of the antenna. Secondly, the satellites must be spaced apart about the geosynchronous arc so that a receiving antenna may be positioned with only a single satellite transmitting in the directional reception range of the antenna.

According to current regulations, individual DBS satellites must be separated at least nine (9) degrees in the geosynchronous arc. Thus, each DBS receiving antenna must have a directional reception range or aperture of plus or minus nine (9) degrees or less as measured from a centerline of the antenna. Although current regulations require a spacing of no less than nine (9) degrees separation, the invention is not limited to this degree of separation. However, according to the invention, the effective reception range of each first antenna or satellite reception antenna must be less than or equal to the minimum satellite separation angle.

FIG. 1 also shows a terrestrial transmitter **20** capable of transmitting in one or more frequencies identical to a frequency transmitted by one of the DBS satellites. The terrestrial transmitter **20** transmits directionally within a certain transmission range T. The transmission range T shown in FIG. 1 is 180 degrees, although the range may be more or less than this number.

The antenna structure **22** which may be used at user location **14** (FIG. 1) to pick up signals transmitted according to the invention is illustrated in FIG. 2. The first antenna **16** is designed to receive direct broadcast satellite signals. The first antenna **16** includes a collecting dish **24** and a feed-horn assembly **26** for receiving the signals reflected and concentrated by the dish. Those skilled in the art will readily appreciate that the feed-horn assembly **26** includes a probe, which is not shown in FIG. 2, for picking up the signal received by the antenna. The probe feeds the signal to signal processing equipment for extracting information from the received signal. This signal processing equipment is well known in the art and does not form a part of this invention. Also, those skilled in the art will appreciate that numerous types of assemblies may be used alternatively to the feed-horn assembly **26** for collecting signals reflected by the dish **24**.

The first antenna **16** includes an antenna centerline **28**. As dictated by the frequency of the signal received, the first antenna **16** has a maximum directional reception range d max. as measured from the antenna centerline **28**. The total reception range for antenna **16** shall be referred to in this disclosure and the accompanying claims as the "satellite" or "first" directional reception range, and is equal to two times the reception range d max. Signals propagating in a direction outside of this satellite directional reception range or aperture about the antenna centerline **28** from user location **14** cannot be received by the first antenna **16**.

Referring still to FIG. 2, the antenna structure **22** at the user location **14** further includes the separate second antenna **18** for receiving the terrestrially transmitted signals. The second antenna **18** is shown as a feed-horn type antenna, however, those skilled in the art will readily appreciate that the second antenna may include a circular wave guide antenna, flat plate antenna, slot antenna, dipole antenna or multi-dipole antenna. Regardless of the antenna type, the antenna will include a suitable signal pick-up assembly for picking up the signal received by the antenna and feeding the signal to suitable signal processing equipment. This processing equipment is separate from the processing equipment for processing the signals received by the first antenna **16**. Also, although the second antenna **18** is shown connected to the same structure as the first antenna **16**, the first and second antennas may be completely separate. In any event, the second antenna **18** is preferably rotatable about a vertical axis as shown at B in FIG. 2 to direct the antenna for optimally receiving the terrestrial transmitted signals.

As with the first antenna **16**, the second antenna **18** includes a centerline **30** and may receive signals travelling only within a directional reception range r max. about the antenna centerline **30**. The total reception range for second antenna **18** shall be referred to in this disclosure and the accompanying claims as the "terrestrial" or "second" directional reception range, and is equal to two times the reception range r max. Signals travelling to user location **14** along a route outside that terrestrial directional reception range cannot be received by the second antenna **18**.

Referring again to FIG. 1, the first antenna 16 according to the invention, is directed to receive signals from one of the satellites, satellite 12*d* for example. The azimuth and elevation at which the first antenna 16 must be directed for optimally receiving signals from satellite 12*d* may be 247.3 and 25.7 respectively, for example. The second antenna 18 is directed with its centerline 30 pointing generally to the terrestrial transmitting location of the terrestrial transmitter 20 and essentially horizontally. Ignoring the elevation difference between the first and second antennas 16 and 18, respectively, the azimuth difference between the centerlines 28 and 30 of the two antennas and this example is approximately 67.7 degrees.

In the orientation shown in FIG. 1, the first antenna 16 cannot receive signals from the terrestrial transmitter 20. The reason for this is that the directional signals transmitted from the terrestrial transmitter 20 are all travelling in a direction or along a route outside of the satellite directional reception range of the first antenna 16. Similarly, the direction in which the satellite 12*d* transmits with respect to the user location 14 is outside of the terrestrial directional reception range of the second antenna 18. Thus, the second antenna 18 cannot receive signals transmitted by the satellite 12*d*. Furthermore, in this example, the second antenna 18 cannot receive any signals transmitted by any of the satellites 12*a–d*. Thus, in the orientation of the first and second antenna 16 and 18 as shown in FIG. 1 and with the position of the satellites 12*a–d* and terrestrial transmitter 20, the terrestrial transmitter may transmit on a frequency identical to the frequency of signals transmitted by the satellites without any interference in the signals received at the two antennas.

Those skilled in the art will readily appreciate that the elevation of the first antenna 16 may be high enough with respect to horizontal so that the second antenna 18 may be aligned along the same azimuth as the first antenna without any interference between the signals received by the two antennas on the identical frequency. However, where there are numerous satellites at different azimuths and elevations with respect to the user location 14, the first and second antennas 16 and 18 may have to be positioned at different azimuths as illustrated in FIG. 1 in order to prevent interference.

Referring to FIG. 3, a plurality of terrestrial transmitters 32 are required to provide a signal strong enough to be received over a large area. Each transmitter 32 in FIG. 3 transmits directionally in an azimuth range A of approximately 180 degrees and out to an effective reception range R. With this transmitter spacing and transmission range, the signals from the terrestrial transmitters may be received from any location within the geographic area G. Although the directional range of 180 degrees is shown for purposes of example, the terrestrial transmissions may be in other ranges within the scope of this invention.

The method according to the invention is used in situations in which satellite signals are being transmitted in a first frequency for reception with the first antenna 16. The first antenna 16 is adapted to receive signals only within the satellite directional reception range about the antenna centerline 28. The method includes transmitting signals in the first frequency directionally in a range outside of the satellite directional reception range of the first antenna 16. Signals transmitted by the terrestrial transmitter are received by the second antenna 18 at the user location 14. The second antenna 18 is adapted to receive signals only within the terrestrial directional reception range about the antenna centerline 30.

This directional terrestrial transmission according to the invention allows terrestrial transmission at an identical frequency as that used by satellites, and particularly DBS without interference between the two transmissions. This allows the DBS spectrum and perhaps other satellite spectra to be reused for terrestrial transmissions. The terrestrial transmissions may be for television signals or any other data, including internet communications, voice data, other video, or any other type of data.

The above described preferred embodiments are intended to illustrate the principles of the invention, but not to limit the scope of the invention. Various other embodiments and modifications to these preferred embodiments may be made by those skilled in the art without departing from the scope of the following claims.

What is claimed is:

1. An apparatus for simultaneously transmitting terrestrial signals on a common frequency with satellite signals transmitted from a satellite, the satellite transmitting satellite signals at a first frequency to a user location for reception only within a satellite directional reception range about the user location, the apparatus comprising:

(a) a directional terrestrial transmitter for transmitting terrestrial signals at the first frequency in a limited azimuth range around the location of the terrestrial transmitter, the terrestrial transmitter being located with respect to the user location such that the terrestrial transmitter transmits to the user location along a route which is outside of the satellite directional reception range.

ONLY ONE STEP REQUIRED

2. The apparatus of claim 1 wherein satellite signals are transmitted from a plurality of satellites in geosynchronous orbit, each satellite separated from each other satellite in a geosynchronous arc by an angle greater than one half of the satellite directional reception range and the satellites together transmit satellite signals to the user location only within a combined satellite signal transmission range about the user location, and wherein:

(a) the terrestrial transmitter transmits only in directions which are outside of the combined satellite signal transmission range and an angle equal to one half of the satellite directional reception range outside of the boundaries of the combined satellite signal transmission range.

3. The apparatus of claim 2 further comprising:

(a) a plurality of terrestrial directional transmitters, each transmitting from a different terrestrial transmission location and each transmitting directionally in a limited azimuth range.

4. The apparatus of claim 1 wherein the first frequency is in a range of 12.2 gigahertz to 12.7 gigahertz.

5. The apparatus of claim 1 wherein the first frequency is above 12.2 gigahertz.

12 GHz Band

6. The apparatus of claim 1 wherein the satellite directional reception range is approximately eighteen (18) degrees.

7. A method for simultaneously providing terrestrial signals on a common frequency with satellite signals transmitted from a satellite, where the satellite is transmitting at a first frequency along a satellite transmission axis extending from the satellite to a terrestrial user location, the method comprising the step of:

(a) transmitting terrestrial signals at the first frequency in a limited azimuth range from a terrestrial transmitter, the terrestrial transmitter being located with respect to the user location so as to transmit to the user location along a transmission route which is outside of a satellite directional reception range about the user location, wherein the satellite directional reception range comprises a limited directional range substantially centered on the satellite transmission axis.

8. The method of claim 7 further comprising the step of:

(a) transmitting terrestrial signals at the first frequency and within a limited terrestrial azimuth range from a plurality of terrestrial transmitters at different locations.

9. The method of claim 7 wherein the first frequency is in the range of 12.2 gigahertz to 12.7 gigahertz.

10. The method of claim 7 wherein the first frequency is above 12.2 gigahertz.

11. The method of claim 7 wherein the satellite directional reception range is approximately eighteen (18) degrees.

12. An apparatus for facilitating the use of terrestrial transmitted signals which are transmitted on a common frequency simultaneously with satellite signals transmitted from a satellite, the satellite transmitting satellite signals at a first frequency to a terrestrial user location along a satellite transmission axis, the apparatus comprising:

(a) a terrestrial transmitter for transmitting terrestrial signals at the frequency to the user location, the terrestrial transmitter being location with respect to the user location such that the terrestrial transmitter transmits to the user location along a route which is outside of a satellite directional reception range about the user location, wherein the satellite directional reception range comprises a limited directional range substantially centered on the satellite transmission axis, and

(b) a terrestrial receiving antenna at the user location for receiving signals at the first frequency only within a terrestrial directional reception range about a centerline of the terrestrial antenna, the terrestrial antenna being aligned to receive signals transmitted at the first frequency from the terrestrial transmitter location, and being aligned so that the satellite transmission axis is outside of the terrestrial directional reception range.

13. The apparatus of claim 12 wherein satellite signals are transmitted from a plurality of satellites in geosynchronous orbit, each satellite separated from each other satellite in a geosynchronous arc by an angle greater than an angle equal to one half of the satellite directional reception range and the satellites together transmit satellite signals to the user location only within a combined satellite signal transmission range about the user location, and wherein

(a) the terrestrial transmitter transmits only in directions which are outside of the combined satellite signal transmission range and an angle equal to one half of the satellite directional reception range outside of the boundaries of the combined satellite signal transmission range.

14. The apparatus of claim 13 further comprising:

(a) a plurality of terrestrial transmitters each transmitting from a different terrestrial transmission location and each transmitting directionally in a limited azimuth range.

15. The apparatus of claim 12 wherein the first frequency is in a range of 12.2 gigahertz to 12.7 gigahertz.

16. The apparatus of claim 12 wherein the first frequency is above 12.2 gigahertz.

17. The apparatus of claim 12 wherein the satellite directional reception range is approximately eighteen (18) degrees.

18. An apparatus for simultaneously transmitting terrestrial signals on a common frequency with satellite signals transmitted from a satellite, the satellite transmitting satellite signals at a first frequency to a user location for reception only within a satellite directional reception range about the user location, the apparatus comprising:

(a) a terrestrial for transmitting terrestrial signals at the first frequency from a fixed terrestrial location which forms a fixed geometry with the user location and the satellite, the terrestrial transmitter being located with respect to the user location such that the terrestrial transmitter transmits to the user location along a route which is outside of the satellite directional reception range about the user location.

19. The apparatus of claim 18 wherein satellite signals are transmitted from a plurality of satellites in geosynchronous orbit, each satellite separated from each other satellite in a geosynchronous arc by an angle greater than one half of the satellite directional reception range and the satellites together transmit satellite signals to the user location only within a combined satellite signal transmission range about the user location, and wherein:

(a) the terrestrial transmitter transmits only in directions which are outside of the combined satellite signal transmission range and an angle equal to one half of the satellite directional reception range outside of the boundaries of the combined satellite signal transmission range.

20. The apparatus of claim 18 further comprising:

(a) a plurality of terrestrial transmitters, each transmitting from a different fixed terrestrial transmission location which forms a fixed geometry with the satellite and the user location.

21. The apparatus of claim 18 wherein the first frequency is in a range of 12.2 gigahertz to 12.7 gigahertz.

22. The apparatus of claim 18 wherein the first frequency is above 12.2 gigahertz.

23. The apparatus of claim 18 wherein the satellite directional reception range is approximately eighteen (18) degrees.

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LOCAL SIGNALS

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United States Patent [19]

Tawil et al.

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[45] Date of Patent: Jun. 2, 1998

We've been doing this a long time

[54] **APPARATUS AND METHOD FOR REUSING SATELLITE BROADCAST SPECTRUM FOR TERRESTRIALLY BROADCAST SIGNALS**

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[73] Assignee: Northpoint Technology, Ltd., Austin, Tex.

[21] Appl. No.: 731,244

1996

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[51] Int. Cl.[6] H04H 1/00; H04B 7/185

[52] U.S. Cl. 455/3.2; 455/13.3

[58] Field of Search 455/3.2, 427, 430, 455/12.1, 13.3, 63, 272, 188.1, 179.1; 348/6, 12, 13

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Primary Examiner—Nguyen Vo

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[57] **ABSTRACT**

A first antenna (16) at a user location (14) receives signals at a first frequency where the signals are travelling only within a first directional reception range as measured from a centerline (28) of the first antenna (16). The first antenna (16) has its centerline (28) aligned to receive direct broadcast satellite signals transmitted from a satellite in geosynchronous orbit about the earth. A second antenna (18) at the user location (14) receives signals at the first frequency where the signals are travelling only within a second directional reception range as measured from a centerline (30) of the second antenna (18). The second antenna (18) is aligned to receive signals transmitted at the first frequency from a terrestrial transmitting location remote from the user location. A terrestrial transmitter transmits signals at the first frequency and directionally within a terrestrial azimuth range from the terrestrial transmitting location. The terrestrial transmitting location is located with respect to the user location (14) such that the terrestrial transmitter (20) transmits in directions only outside of the directional reception range of the first antenna (16). The satellite (12) is positioned with respect to the user location (14) such that the satellite transmits directional in directions outside of the directional reception range of the second antenna (18).

Direction broadca.

12 Claims, 2 Drawing Sheets

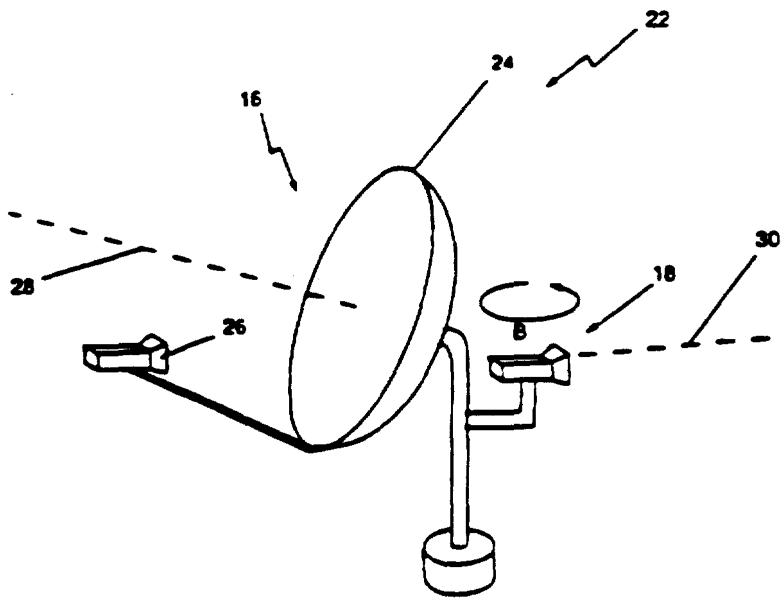


Figure 1

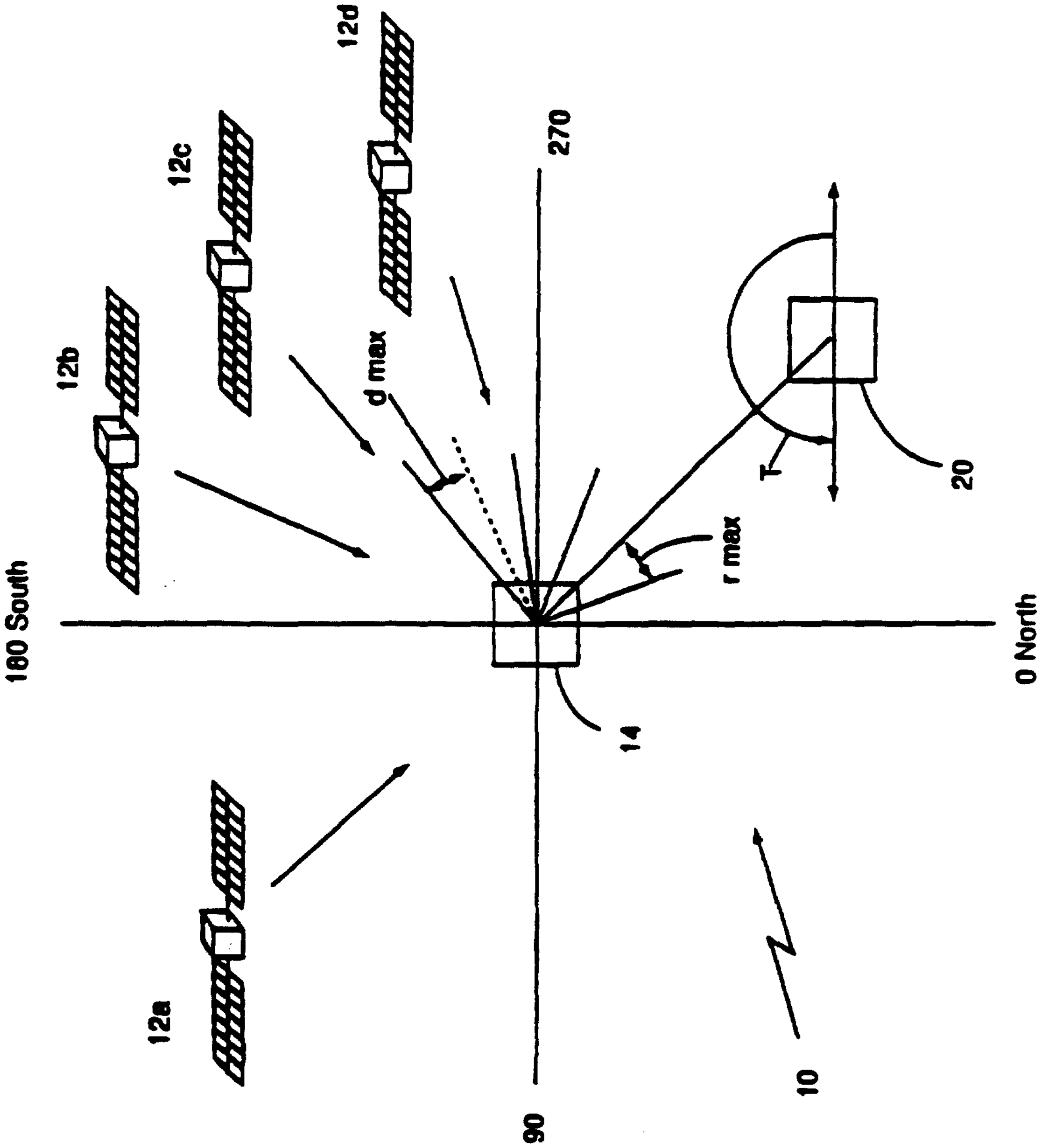


Figure 2

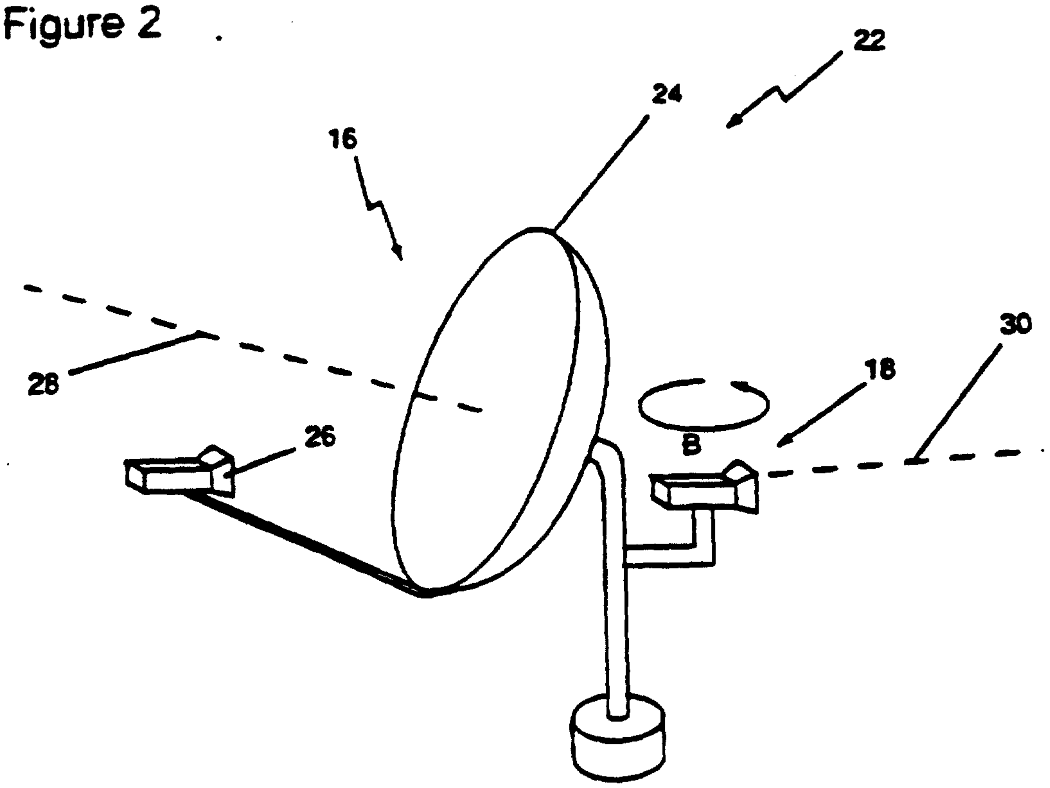
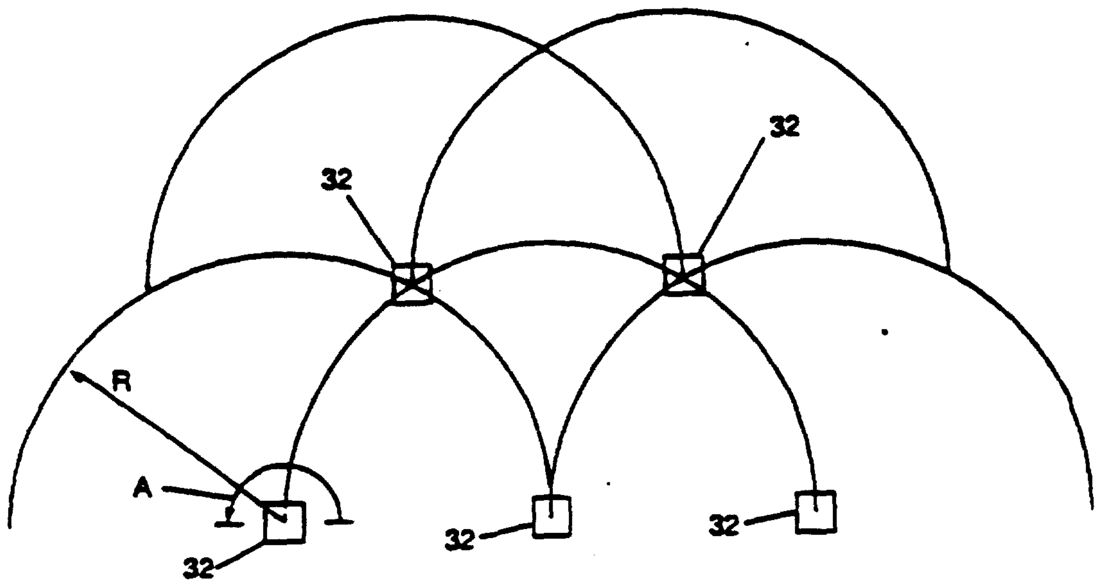


Figure 3



APPARATUS AND METHOD FOR REUSING SATELLITE BROADCAST SPECTRUM FOR TERRESTRIALLY BROADCAST SIGNALS

BACKGROUND OF THE INVENTION

This invention relates to apparatus and methods for broadcasting and receiving data, including digital television signals and voice signals. More particularly, this invention relates to an apparatus and method for providing terrestrial transmissions simultaneously along with direct broadcast satellite transmissions on a common frequency.

Currently, television signals may be received from a satellite in geosynchronous orbit about the earth. The television signals are transmitted from a terrestrial transmitter to the satellite and then retransmitted from the satellite so that the signals can be received by terrestrial receivers within a certain geographic receiving area within a line of sight of the satellite. In addition to television signals, other types of data may also be transmitted to consumers through satellites in geosynchronous orbit.

Direct broadcast satellite service (DBS) refers to satellite transmission of television signals directly for use by individual households or subscribers having the proper signal receiving equipment. The U.S. Federal Communications Commission has dedicated the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. Sixteen signal carriers are located within the DBS spectrum, each carrier carrying several individual television channels. Depending upon the compression technology applied to these signals, literally hundreds of separate channels may be available through DBS. A great benefit of the DBS system as opposed to prior satellite systems is that only a small dish-type antenna is required to receive the DBS signals and the alignment of the receiving dish is not critical. Also, the DBS system will provide high quality reception at any point in the geographic receiving area of a satellite without the expense of land transmission lines such as those required for cable television.

Current regulations require that DBS satellites be separated from each other by at least nine (9) degrees in a geosynchronous arc. The receiving antenna for DBS signals must, therefore, be limited to receiving signals in a directional range measuring plus or minus nine (9) degrees from a centerline of the antenna. Receiving signals in a range wider than the satellite spacing would cause interference by signals transmitted by different satellites on the same frequency.

U.S. Pat. No. 5,483,663 is directed to a system having a receiver arrangement in which DBS and terrestrial signals are received within similar frequency bands. The system shown in the 5,483,663 patent may be implemented with a multiple antenna arrangement, or with a single, moveable antenna. In the multiple antenna arrangement, two separate antennas direct the received signals to a common propagation path for processing as if they were received by a single antenna and transmitted from a single location. In the single antenna arrangement, the antenna is movable between a position to receive DBS signals and another position to receive terrestrial signals.

The advantage of the system shown in U.S. Pat. No. 5,483,663 is that local originating signals, whether television signals or other data, may be received simultaneously with DBS signals, and processed with the same equipment as that used to process the DBS signals. The local originating signals may carry local programming which may be received along with the national or regional DBS programming.

However, since the signals received in the system sh in U.S. Pat. No. 5,483,663 are combined or received on same antenna structure at different points in time, terrest and DBS signals cannot be received simultaneously or common frequency.

Despite the advantages of DBS and the advantages of t system shown in U.S. Pat. No. 5,483,663, the DBS syst ties up a portion of the electromagnetic spectrum whi would otherwise be available for terrestrial signal transm sions.

SUMMARY OF THE INVENTION

It is an object of the invention to provide terrestrial transmitted signals simultaneously with satellite transmitt signals at the same frequency. The invention includes a apparatus and method for providing terrestrial and satelli signals simultaneously at a common frequency.

The object of the invention is accomplished by utilizin receiving antennas with a limited directional reception rang and transmitting the terrestrial signals in a different range o directions than those in which the satellite signals a transmitted. The invention requires two separate receivin antennas feeding two sets of decoding and demodulatin processing systems for utilizing the received signals. Bot receiving antennas are adapted to receive signals only withi a particular directional range. The range is measured from a centerline of the particular antenna.

In order to ensure no interference between the satellite and terrestrially transmitted signals, the terrestrial signals are transmitted directionally within a terrestrial azimut range which is outside the azimuth range in which the satellite signals are transmitted either by a single satellite or multiple satellites. The terrestrial transmit azimuth range is chosen so that it does not include any directions in which the satellite signal receiving antenna must be directed to receive signals from any satellite. In order to cover a large area for local reception, a plurality of terrestrial transmitters are spread out over an area with directional transmitted areas overlapping to ensure the terrestrial signals may be received clearly at each location within the desired service area.

These and other objects, advantages, and features of the invention will be apparent from the following description of the preferred embodiments, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation showing the positions of a plurality of satellites in relation to a single terrestrial transmitter and a receiver or user location.

FIG. 2 is a somewhat schematic representation of a receiving antenna structure for receiving satellite and terrestrial transmitted signals at a common frequency.

FIG. 3 is a schematic representation of the spacing for a number of terrestrial transmitters required to allow reception over a large geographic area.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus according to the invention for providing satellite and terrestrially transmitted signals simultaneously on the same frequency illustrated in FIGS. 1 and 2. As shown in FIG. 1, the system **10** may be utilized with one or more satellites in geosynchronous orbit about the earth. FIG. 1 shows four satellites **12**_a_, **12**_b_, **12**_c_, and **12**_d_ spaced apart at four separate directions from a user location **14**. In geosynchronous orbit, each satellite remains at a fixed location with respect to the earth's surface, and thus, with respect to the user location 14. First and second antenna 16 and 18, respectively, which will be discussed in detail with reference to FIG. 2 are located at the user location 14.

Each of these satellites 12a–d is positioned in geosynchronous orbit about the center of the earth, and is positioned at a certain longitude and latitude above the earth's surface. As is known by those skilled in the art, a receiving antenna may be directed at a certain elevation and direction or azimuth toward a desired satellite location for receiving signals from the particular satellite.

Currently, all direct broadcast satellites within the line of sight of North America are positioned at longitudes and latitudes requiring the receiving antenna to face in a southerly direction from North America to receive signals. Although FIG. 1 shows four satellites 12a–d for purposes of describing the invention herein, more or fewer satellites may be spaced apart within a line of sight of a certain geographical area. Eight satellites are currently within a line of sight of North America. Table 1 sets out the longitudinal location of each satellite and for purposes of example, the azimuth and elevation at which a receiving antenna must be directed from a location at Austin, Tex. for receiving signals from each satellite. All azimuth directions and elevations are measured to a centerline of the antenna which will be discussed below with respect to FIG. 2. The term "azimuth" refers to the direction with respect to a reference direction such as due north, commonly zero degrees. "Elevation" refers to the angle of the antenna centerline above horizontal.

DBS locations

Satellite Longitude	Azimuth	Elevation
61.5	124.5	37.3
101	186.4	54.6
110	203.3	52.3
119	217.7	47.8
148	247.3	25.7
157	253.3	17.9
166	258.8	10.1
175	263.5	2.3

DBS satellites all transmit different signals in the same frequency band. The U.S. Federal Communications Commission has set aside the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. In order to ensure no interference from signals between two adjacent satellites, two conditions must be met. First, the receiving antenna must be limited to receive signals only within a certain reception range about the centerline of the antenna. Secondly, the satellites must be spaced apart about the geosynchronous arc so that a receiving antenna may be positioned with only a single satellite transmitting in the directional reception range of the antenna.

According to current regulations, individual DBS satellites must be separated at least nine (9) degrees in the geosynchronous arc. Thus, each DBS receiving antenna must have a directional reception range or aperture of plus or minus nine (9) degrees or less as measured from a centerline of the antenna. Although current regulations require a spacing of no less than nine (9) degrees separation, the invention is not limited to this degree of separation. However, according to the invention, the effective reception range of each first antenna or satellite reception antenna must be less than or equal to the minimum satellite separation angle.

FIG. 1 also shows as terrestrial transmitter 20 capable of transmitting in one or more frequencies identical to a frequency transmitted by one of the DBS satellites. The terrestrial transmitter 20 transmits directionally within a certain transmission range T. The transmission range T shown in FIG. 1 is 180 degrees, although the range may be more or less than this number.

The antenna structure 22 according to the invention at the user location 14 in FIG. 1 is illustrated by way of example in FIG. 2. The first antenna 16 is designed to receive direct broadcast satellite signals. The first antenna 16 includes a collecting dish 24 and a feed-horn assembly 26 for receiving the signals reflected and concentrated by the dish. Those skilled in the art will readily appreciate that the feed-horn assembly 26 includes a probe, which is not shown in FIG. 2, for picking up the signal received by the antenna. The probe feeds the signal to signal processing equipment for extracting information from the received signal. This signal processing equipment is well known in the art and does not form a part of this invention. Also, those skilled in the art will appreciate that numerous types of assemblies may be used alternatively to the feed-horn assembly 26 for collecting signals reflected by the dish 24.

The first antenna 16 includes an antenna centerline 28. As dictated by the frequency of the signal received, the first antenna 16 has a maximum directional reception range d max, as measured from the antenna centerline 28. Signals propagating in a direction outside of this reception range or aperture about the antenna centerline 28 cannot be received by the first antenna 16.

Referring still to FIG. 2, the antenna structure 22 at the user location 14 further includes the separate second antenna 18 for receiving the terrestrially transmitted signals. The second antenna 18 is shown as a feed-horn type antenna, however, those skilled in the art will readily appreciate that the second antenna may include a circular wave guide antenna, flat plate antenna, slot antenna, dipole antenna or multi-dipole antenna. Regardless of the antenna type, the antenna will include a suitable signal pick-up assembly for picking up the signal received by the antenna and feeding the signal to suitable signal processing equipment. This processing equipment is separate from the processing equipment for processing the signals received by the first antenna 16. Also, although the second antenna 18 is shown connected to the same structure as the first antenna 16, the first and second antennas may be completely separate. In any event, the second antenna 18 is preferably rotatable about a vertical axis as shown at B in FIG. 2 to direct the antenna for optimally receiving the terrestrial transmitted signals.

As with the first antenna 16, the second antenna 18 includes a centerline 30 and may receive signals travelling only within a directional reception range r max, about the antenna centerline 30. Signals travelling in a direction outside that range cannot be received by the second antenna 18.

Referring again to FIG. 1, the first antenna 16 according to the invention, is directed to receive signals from one of the satellites, satellite 12d for example. The azimuth and elevation at which the first antenna 16 must be directed for optimally receiving signals from satellite 12d may be 247.3 and 25.7 respectively, for example. The second antenna 18 is directed with its centerline 30 pointing generally to the terrestrial transmitting location of the terrestrial transmitter 20 and essentially horizontally. Ignoring the elevation difference between the first and second antennas 16 and 18, respectively, the azimuth difference between the centerlines

28 and 30 of the two antennas and this example is approximately 67.7 degrees.

In the orientation shown in FIG. 1. the first antenna 16 cannot receive signals from the terrestrial transmitter 20. The reason for this is that the directional signals transmitted from the terrestrial transmitter 20 are all travelling in a direction outside of the reception range of the first antenna 16. Similarly. the direction in which the satellite 12*d* transmits with respect to the user location 14 is outside of the reception range of the second antenna 18. Thus. the second antenna 18 cannot receive signals transmitted by the satellite 12*d*. Furthermore. in this example. the second antenna 18 cannot receive any signals transmitted by any of the satellites 12*a*–*d*. Thus. in the orientation of the first and second antenna 16 and 18 as shown in FIG. 1 and with the position of the satellites 12*a*–*d* and terrestrial transmitter 20. the terrestrial transmitter may transmit on a frequency identical to the frequency of signals transmitted by the satellites without any interference in the signals received at the two antennas.

Those skilled in the art will readily appreciate that the elevation of the first antenna 16 may be high enough with respect to horizontal so that the second antenna 18 may be aligned along the same azimuth as the first antenna without any interference between the signals received by the two antennas on the identical frequency. However. where there are numerous satellites at different azimuths and elevations with respect to the user location 14. the first and second antennas 16 and 18 may have to be positioned at different azimuths as illustrated in FIG. 1 in order to prevent interference.

Referring to FIG. 3. a plurality of terrestrial transmitters 32 are required to provide a signal strong enough to be received over a large area. Each transmitter 32 in FIG. 3 transmits directionally in an azimuth range A of approximately 180 degrees and out to an effective reception range R. With this transmitter spacing and transmission range. the signals from the terrestrial transmitters may be received from any location within the geographic area G. Although the directional range of 180 degrees is shown for purposes of example. the terrestrial transmissions may be in other ranges within the scope of this invention.

The method according to the invention comprises receiving satellite signals in a first frequency with the first antenna 16. The first antenna 16 is adapted to receive signals only within a first directional reception range from the antenna centerline 28. The method also includes transmitting signals in the first frequency directionally in a range outside of the directional reception range of the first antenna 16. Signals transmitted by the terrestrial transmitter are received by the second antenna 18 at the user location 14. The second antenna 18 is also adapted to receive signals only within a directional reception range with respect to the antenna centerline 30.

This combination of directional receiving antennas 16 and 18. and directional terrestrial transmission allows terrestrial transmissions at an identical frequency as that used by satellites. and particularly DBS without interference between the two transmissions. This allows the DBS spectrum and perhaps other satellite spectra to be reused for terrestrial transmissions. The terrestrial transmissions may be for television signals or any other data. including internet communications. voice data. other video. or any other type of data.

The above described preferred embodiments are intended to illustrate the principles of the invention. but not to limit the scope of the invention. Various other embodiments and modifications to these preferred embodiments may be made by those skilled in the art without departing from the scope of the following claims.

We claim:

1. An apparatus for simultaneously providing terrestrial transmitted signals on a common frequency with direct broadcast satellite signals transmitted from a satellite in a first satellite location in geosynchronous orbit about the earth. the apparatus comprising:

(a) a first antenna at a user location for receiving signals at a first frequency only within a first directional reception range as measured from a centerline of the first antenna. the first antenna having its centerline aligned to receive direct broadcast satellite signals transmitted from the satellite;

(b) a second antenna at the user location for receiving signals at the first frequency only within a second directional reception range as measured from a centerline of the second antenna. the second antenna being aligned to receive signals transmitted at the first frequency from a terrestrial transmitter location remote from the user location with the direct broadcast satellite signals transmitted in directions outside of the second directional reception range; and

(c) a terrestrial transmitter for transmitting signals at the first frequency and directionally within a terrestrial azimuth range from the terrestrial transmitter location. the terrestrial transmitter location being located with respect to the user location such that the terrestrial transmitter transmits in directions only outside of the directional reception range of the first antenna.

2. The apparatus of claim 1 wherein direct broadcast satellite signals are transmitted from a plurality of satellites in geosynchronous orbit. each satellite separated from each other satellite in a geosynchronous arc by an angle greater than the first directional range of the first antenna and each satellite within a satellite azimuth range within which the first antenna may be positioned to receive signals from any of the satellites. and wherein:

(a) the terrestrial azimuth range is separated from the satellite azimuth range by an angle greater than approximately the sum of directional reception range of the first antenna and the directional reception range of the second antenna.

3. The apparatus of claim 2 further comprising:

(a) a plurality of terrestrial transmitters each transmitting from a different terrestrial transmission location and each transmitting in a substantially common azimuth range.

4. The apparatus of claim 1 wherein the first frequency is in a range of 12.2 gigahertz to 12.7 gigahertz.

5. The apparatus of claim 1 wherein the first frequency is above 12.2 gigahertz.

6. The apparatus of claim 1 wherein the second antenna is selected from the group consisting of circular wave guide antennas. feed-horn antennas. flat plate antennas. slot antennas. dipole antennas. and multi-dipole antennas.

7. The apparatus of claim 1 wherein the directional reception range of the first antenna is approximately nine (9) degrees.

8. A method for simultaneously providing local originating signals on a common frequency with direct broadcast satellite signals transmitted from a satellite. where the satellite is in a first satellite location in geosynchronous orbit about the earth. the method comprising the steps of:

(a) at a user location, receiving direct broadcast satellite signals at a first frequency with a first antenna adapted to receive signals at the first frequency only within a first directional reception range as measured from a centerline of the first antenna;

(b) transmitting terrestrial signals at the first frequency and in a terrestrial azimuth range from a terrestrial transmitter, the terrestrial azimuth range being outside of the directional reception range of the first antenna positioned to receive direct broadcast satellite signals from the satellite; and

(c) at the user location, remote from the terrestrial transmitter, receiving the terrestrial signals with a second antenna adapted for receiving signals at the first frequency only within a second directional reception range as measured from a centerline of the second antenna, the second antenna being aligned so that the direct broadcast satellite signals transmitted by the satellite are not transmitted within the directional reception range of the second antenna.

9. The method of claim 8 further comprising the step of:

(a) transmitting terrestrial signals at the first frequency and terrestrial azimuth range from a plurality of terrestrial transmitters.

10. The method of claim 8 wherein the first frequency is in the range of 12.2 gigahertz to 12.7 gigahertz.

11. The method of claim 8 wherein the first frequency is above 12.2 gigahertz.

12. The method of claim 8 wherein the directional range of the first and second antenna is approximately nine (9) degrees from the antenna centerline.

* * * * *

- SHARING DBS SPECTRUM

US005483663A

United States Patent [19]

Tawil

[11] **Patent Number:** 5,483,663

[45] **Date of Patent:** Jan. 9, 1996

[54] **SYSTEM FOR PROVIDING LOCAL ORIGINATING SIGNALS WITH DIRECT BROADCAST SATELLITE TELEVISION SIGNALS**

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[73] Assignee: Diversified Communication Engineering, Inc., Austin, Tex.

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1994

[51] Int. Cl.[6] H04H 1/00

[52] U.S. Cl. 455/3.2; 348/20; 348/6; 455/180.1

[58] Field of Search 455/3.2, 188.1, 455/180.1, 20; 348/470, 21, 6, 12, 13; H04N 7/20

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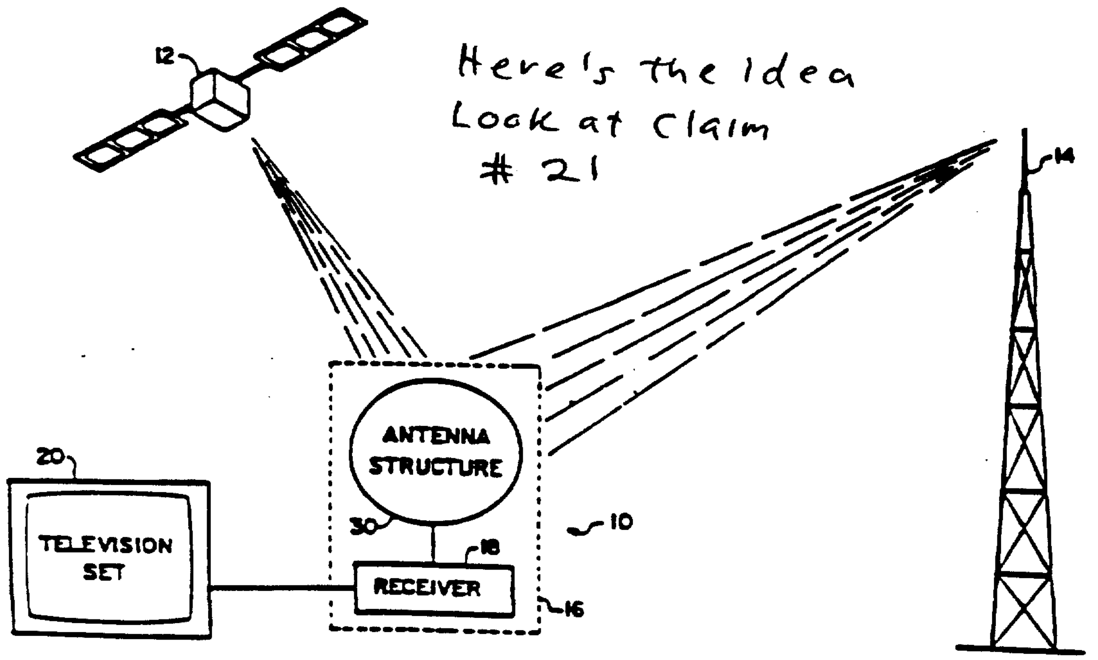
Primary Examiner—Victor R. Kostak
Assistant Examiner—Juan Gabriel Acosta
Attorney, Agent, or Firm—Russell D. Culbertson; Shaffer & Culbertson

[57] **ABSTRACT**

An apparatus for providing local programming with direct broadcast satellite transmissions includes a terrestrial transmitter for transmitting converted local channel signals in a first frequency band. The first frequency band is contained within a satellite broadcast frequency band in which the direct broadcast satellite channels are transmitted. The apparatus also includes at each user or subscriber location, a first antenna for receiving the converted local channel signals from the terrestrial transmitter and a second antenna for receiving a direct broadcast satellite channel signals from the satellite. The apparatus further includes a combiner for combining the converted local channel signals and the direct broadcast satellite channel signals on a single propagation path. A signal processor/decoder processes the combined signals on the single propagation path to produce a desired channel output to drive a television set. To the processor/decoder the combined channel signal appears as if it had been all broadcast directly from the satellite. Therefore, the apparatus requires no additional receiver for receiving local programming along with regional and national programming provided by satellite transmission.

21 Claims, 3 Drawing Sheets

Here's the Idea
Look at Claim
21



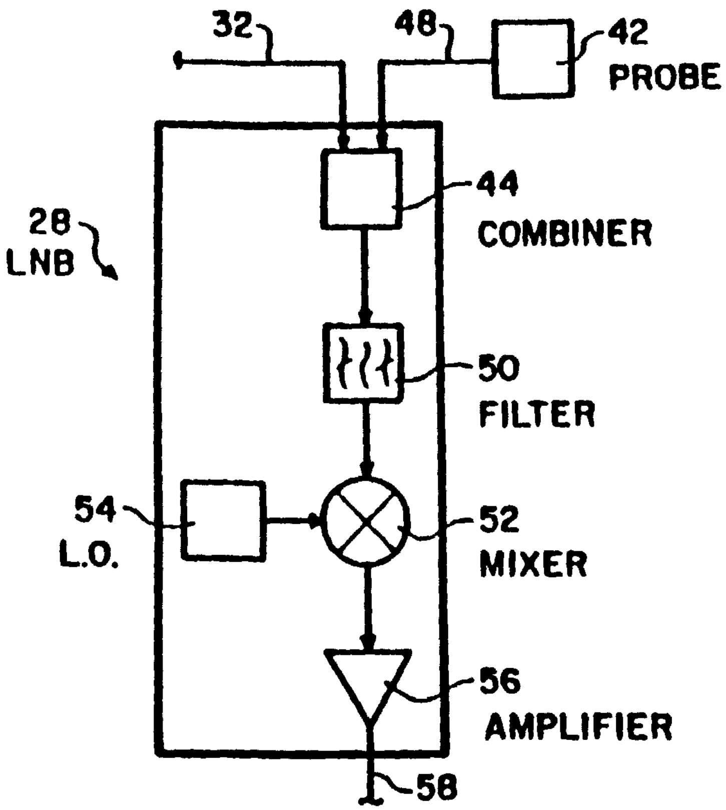
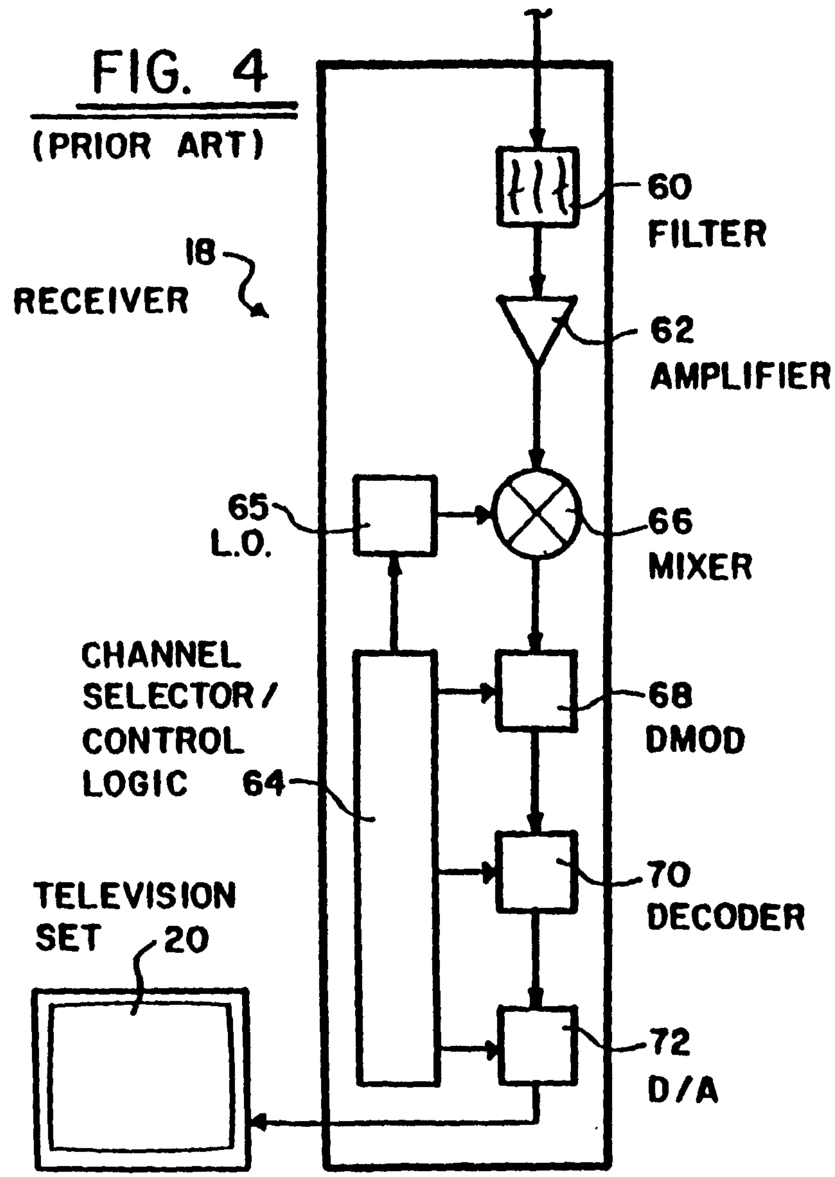


FIG. 3

FIG. 4

(PRIOR ART)



SYSTEM FOR PROVIDING LOCAL ORIGINATING SIGNALS WITH DIRECT BROADCAST SATELLITE TELEVISION SIGNALS

BACKGROUND OF THE INVENTION

This invention relates to apparatus and methods for broadcasting and receiving television signals. More particularly, this invention relates to an apparatus and method for providing local originating channels along with direct broadcast satellite television channels transmitted from a satellite.

Television signals may be received from a satellite in geosynchronous orbit in which it is stationary with respect to a geographic receiving area. Typically, the television signals are transmitted from a terrestrial transmitter to the satellite and then retransmitted from the satellite so that the signals can be received by terrestrial receivers within the geographic receiving area, that is, within a line of sight of the satellite.

Direct broadcast satellite service ("DBS") refers to satellite transmission of television signals directly for use by individual households or subscribers having the proper signal receiving equipment. The U.S. Federal Communications Commission has dedicated the electromagnetic spectrum from 12.2 Giga-Hertz to 12.7 Giga-Hertz for DBS broadcasting. Sixteen signal carriers are located within the DBS spectrum, each carrier carrying several individual television channels. Depending upon the compression technology applied to these signals, literally hundreds of separate channels may be available through DBS. A great benefit of the DBS system as opposed to prior satellite systems is that only a small dish-type antenna is required to receive the DBS signals and the alignment of the receiving dish is not critical. Also, the DBS system will provide high quality reception at any point in the geographic receiving area of a satellite without the expense of land transmission lines such as those required for cable television.

The DBS system requires that a subscriber purchase or rent both a special DBS signal processing unit or receiver and a DBS satellite signal receiving antenna. The receiver and antenna are usually provided as one assembly having an outdoor unit and an indoor unit. The special DBS receiver receives all sixteen carriers and includes channel selecting logic for selecting a desired program channel from the received carriers. To produce a single channel program output to a television set, the DBS receiver channel selecting logic selects one of the sixteen carriers and then demodulates and decodes the encoded signals. Finally the receiver converts the desired channel signal from digital form to analog form to provide the channel input to the television set.

A major problem with the DBS system involves local originating programming or television channels. Since a single DBS satellite transmits to substantially an entire continent, DBS can effectively only provide national or at most regional programming. There is simply not enough room in the DBS spectrum for all local originating programming to be transmitted through the satellite for selection by individual subscribers. Rather, DBS subscribers must obtain local originating programming from other sources such as local broadcast stations, cable, or local wireless sources. These separate sources all require separate receiving equipment. Furthermore, the advantages of DBS are less attractive to potential subscribers because the subscribers must also use a separate system, cable for example, in order to obtain local programming. In fact, there has been great concern that the absence of local programming with DBS may make the DBS system commercially unviable.

SUMMARY OF THE INVENTION

It is therefore a general object of the invention to overcome the above described problems and limitations associated with DBS systems. Particularly, it is an object of the invention to provide an apparatus and method for providing local originating channels along with direct broadcast satellite television channels transmitted from a satellite.

To accomplish this object, a system according to the invention utilizes a terrestrial transmitter to transmit local programming or local channel signals within the frequency band of the DBS satellite transmissions and digitally encoded in a similar fashion. Part of the DBS broadcasting spectrum may be withdrawn from satellite transmission use and instead dedicated for use with local channel signals transmitted from the terrestrial transmitter. Since the terrestrial transmitter has limited range, the same local channel portion of the DBS spectrum dedicated for use with local channel signals may be reused in different geographical areas without interference. In this fashion, DBS subscribers in the entire DBS range are provided with desired local programming without the need of a separate receiver and without having to subscribe to a separate local service provider.

In addition to the terrestrial transmitter and the DBS satellite transmitter, the apparatus according to the invention includes special receiving equipment at each location subscribing to the DBS system. The receiving equipment includes an antenna structure for receiving signals from both the terrestrial transmitter and the satellite transmitter, combining means for combining the signals received by the two antennas, and the regular DBS receiver or signal processing means.

The terrestrial transmitter, located at a terrestrial transmitting location, transmits local channel signals in a frequency band that is included in the band allotted for satellite broadcasting. Preferably the terrestrial transmitter receives local channel signals broadcast locally by some means and then converts the local channel signals from their broadcast frequencies to converted local channel signals in a first frequency band such that they are compatible with the satellite broadcast signals. The first frequency band is contained within a satellite broadcast frequency band which may be the band that DBS has been allotted. In the DBS system, the satellite broadcast frequency band has an approximate lower frequency limit of 12.2 Giga-Hertz and an approximate upper frequency limit of 12.7 GigaHertz. Although more or less of the DBS spectrum may be used for local channel signals, approximately ten percent (10%) of the satellite broadcast frequency band will preferably be vacated for the converted local channel signals. The converted local channel signals could also be transmitted at higher or lower frequencies adjacent to the DBS frequency spectrum.

The antenna structure according to the invention is located at a user location remote from the terrestrial broadcasting location and includes a first antenna and a second antenna. The first antenna is adapted to receive the converted local channel signals in the first frequency band. The second antenna is adapted for receiving direct broadcast satellite television channel signals that are transmitted by the satellite in the satellite broadcast frequency band. Preferably, the first and second antennas are located on a single structure and are separately alignable for peak reception. However, the first and second antennas could also be separate if required for peak reception. Any antennas suitable for receiving the respective frequency signals may be used in the antenna structure according to the invention.

The combining means is also located at the user location and operates to combine the converted local channel signals received by the first antenna and the direct broadcast satellite television signals received by the second antenna. The combining means combines the two sets of signals to form a combined television signal travelling on a single propagation path. Since the individual signals are each within the satellite broadcast frequency band, the combined television signal is also in the satellite broadcast frequency band and may be processed for use as if it were from a single source. When applied to the DBS system for example, the combined signal may be processed by a single DBS receiver without the need for additional or alternative equipment.

The signal processing means or receiver receives the combined television signal from the combining means and processes the combined signal to produce a desired channel output signal to a television set. In the DBS system for example, the signal processing receiver is implemented in a single piece of equipment and includes bandpass filters for filtering the incoming signal and an amplifier. The receiver also includes a mixer, demodulator, digital decoder, and a digital to analog converter all controlled by channel selector/control logic.

The present invention in combination with the DBS system provides a superior alternative to cable television systems. The subscriber not only obtains the high quality reception available with DBS but also obtains local programming without having to subscribe to a separate service or obtain additional receiving equipment.

These and other objects, advantages, and features of the invention will be apparent from the following description of the preferred embodiments, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a transmitting and receiving apparatus embodying the principles of the present invention.

FIG. 2 is an isometric drawing of an antenna structure embodying the principles of the invention.

FIG. 3 is a diagrammatic representation showing a signal combiner according to the invention.

FIG. 4 is a diagrammatic representation showing a receiver and receiver output according to the invention.

FIG. 5 is an isometric drawing of an alternate antenna structure embodying the principles of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1–4 illustrate one preferred apparatus 10 for providing local programming or channels along with direct broadcast satellite television channels according to the invention. The apparatus 10, as shown FIG. 1, is adapted to be used with a satellite transmitter 12 broadcasting direct broadcast satellite television signals in a satellite broadcast frequency band. The apparatus 10 includes a terrestrial transmitter 14 and a signal receiving arrangement 16 located at a location remote from the terrestrial transmitter. Each

individual user or subscriber of the service would have signal receiving arrangement. The terrestrial transmitter 1 transmits in a frequency band within the satellite frequenc band and the receiving arrangement 16 receives the satellit signals and the terrestrial signals and combines them fo processing by a single receiver 18. The disclosed system 1 provides DBS along with local programming while requir ing no additional receiving equipment other than a specia antenna structure described below and means for combinin the separate direct broadcast satellite television channe signals and local channel signals.

The DBS satellite 12, as is well known in the field, includes a transmitter (not shown) and is located in a geosynchronous orbit so that it remains stationary with respect to a certain geographic broadcast area. The satellite 12 itself receives signals from a land-based transmitter (not shown) and then retransmits those signals back to earth. The position of the satellite transmitter 12 allows it to provide a clear signal to a large geographic area. The satellite transmits in a satellite broadcast frequency band. For example, the FCC has allocated the electromagnetic spectrum band from 12.2 Giga-Hertz to 12.7 Giga-Hertz for DBS broadcasting and this frequency band represents the preferred satellite broadcast frequency band. However, the satellite broadcast frequency band for purposes of this invention could also be defined as a frequency band in which the single receiver is adapted to operate. For example, the satellite frequency band could be defined to encompass a frequency band adjacent to the DBS band as well as the allocated DBS band with the terrestrial signal being transmitted in this adjacent band. In this fashion, the invention could be adapted to operate over any desired frequency band.

The terrestrial transmitter 14 comprises any suitable transmitting device for transmitting local channel signals in a first frequency band that is contained within the satellite frequency band. The terrestrial transmitter 14 provides local programming with the local channel signals. Preferably, the terrestrial transmitter 14 will have associated with it means for receiving local programming and signal converting means (not shown) for converting the received local signals into converted local channel signals in the first frequency band. The receiver for the terrestrial transmitter and the signal converter are known in the art and are not described further herein. In a preferred embodiment of the invention operable for DBS systems, the local signals are converted from analog to digital signals before they are transmitted so that the DBS receiver 18 may decode the terrestrially transmitted signals similarly to the satellite transmitted signals.

The terrestrial transmitter 14 has limited range depending upon its broadcast power. For example, depending upon the terrain surrounding the terrestrial transmitter 14, a 100 Watt transmitter can provide a suitable signal for approximately a ten-mile radius around the transmitter. The broadcast power for the terrestrial transmitter is chosen to provide the desired local coverage. Also, since the terrestrial transmitters each have a limited range, the invention encompasses many separate terrestrial transmitters at different geographical locations around the satellite broadcast area for providing the converted local channel signals in just their respective local areas. Since the broadcasting range is limited geographically, each terrestrial transmitter 14 may broadcast in the same first frequency band without providing conflicting signals to any subscriber. Further, in high population density areas when many local channels operate, such as New York City and Los Angeles, for example, the first frequency spectrum could be subdivided to allow portions of the first frequency spectrum to be reused more frequently than other portions of the spectrum. In this fashion, some local channels could be broadcast over a larger area while other local channels could be broadcast over smaller area, depending upon local demand for the channels.

The receiving arrangement 16 is located at a remote location from the location of the terrestrial transmitter 14, such as at an individual household within the range of the terrestrial transmitter. The receiving arrangement 16 includes an antenna structure 30 and the receiver 18, and provides a standard television signal to drive a user or subscriber's television set. The receiving arrangement 16 is adapted to receive the direct broadcast satellite channel signals containing regional or national programming and also the converted local channel signals containing local programming.

Referring to FIG. 2, the antenna structure 30 includes a first antenna 34 for receiving converted local channel signals and a second antenna 36 for receiving direct broadcast satellite signals. The antenna structure 30 also preferably includes a low noise block converter ("LNB") 28 for conditioning the signals from both antennas as described more particularly with reference to FIG. 3. The second antenna 36, as shown in FIG. 2, preferably comprises a standard satellite signal receiving antenna with a reflector dish 38 and a feed-horn assembly 40. The reflector dish 38 reflects and concentrates signals to the feed-horn assembly 40 and these signals are picked up by an antenna probe 42 (FIG. 3) associated with the feed-horn assembly. The first antenna 34 (shown in FIG. 2) preferably comprises a monopole slot antenna. The slot antenna feeds its signal to the LNB 28 through any suitable connection such as a low loss copper coaxial cable 32 (FIG. 3) directly connected to the LNB. Also, the illustrated slot antenna is rotatably mounted on the satellite antenna feed-horn assembly so that it may rotate about its longitudinal axis as shown at arrow A to best position its slot, or slots if more than one is used, for receiving converted local channel signals from the local terrestrial transmitter 14.

Those skilled in the art will readily appreciate that the size of the LNB 28, feed-horn 40 and slot antennal is exaggerated in FIG. 2 relative to the reflector dish for purposes of illustration. In actuality, the reflector dish may be about 18 inches in diameter, the feed-horn 40 wave guide is rectangular approximately one inch wide and one-half inch high, the LNB is rectangular one-half inch high and two and one-half inches long, and the slot antenna for a low gain unit is approximately one inch high and one-half inch in diameter with the slot being about half an inch long.

Referring to FIG. 3, the preferred LNB 28 includes integrally formed combining means 44 for combining the local channel signals and the direct broadcast satellite channel signals on a single propagation path. The combining means 44 in this preferred form of the invention comprises a stripline combiner connected to receive signals from the transmission line 32 connected to the first antenna 34 and the transmission line 48 connected to the probe 42. The stripline combiner 44, such as that shown diagrammatically in FIG. 3, is well known in the art and includes a conductor having dimensions dictated by the frequencies of signals which it carries. Both the transmission line 32 from the slot antenna 34 and the transmission line 48 from the probe 42 may comprise coaxial cable cut to an appropriate length. In a particular embodiment, the length of the coaxial cable may be dictated by the respective impedances of the slot antenna 34 and the probe 42 so that impedances at the combiner are properly matched.

Although the stripline combiner 44 is shown in FIG. 3 as the preferred form of the invention, any suitable combining means may be used within the scope of the invention. For example, a directional coupler (not shown) may be used to couple the signals from the slot antenna 34 onto a transmission line carrying signals from the satellite antenna. Also, the LNB 28 may be integrally formed with the feed-horn antenna probe 42 and the propagation path from the antenna probe to the stripline combiner 44.

The illustrated preferred LNB 28 also preferably includes a band pass filter 50, a mixer 52 controlled by a local oscillator 54, and an amplifier 56. The LNB 28 functions to filter the combined signals and to translate the combined signals into an intermediate frequency band. The LNB 28 also functions to amplify the signals for transmission by suitable transmission line 58 to the DBS broadcast receiver/decoder 18 for further processing.

FIG. 4 illustrates a DBS receiver/decoder 18 as employed according to the invention. The receiver 18 includes a band pass filter 60 and an additional amplifier 62. A channel selector/controller 64 controls a local oscillator 65 which in turn controls a mixer 66 connected in series with the signal path. A demodulator 68, a digital decoder 70, and a digital to analog converter 72 complete the circuitry required to decode the signal. Once fully decoded, the analog output from the receiver 18 represents an NTSC-television signal which can be received by the television set 20. The illustrated DBS receiver/decoder 18 operates under the control of the channel selector controller 64. In operation, a subscriber inputs a desired channel setting either manually or by hand-held remote (not shown) on the selector/controller 64 which causes the mixer 66 to select the desired carrier signal from the several carrier signals reaching the receiver/decoder 18. The demodulator 68 then produces a stream of digital signals from this single carrier which is then decoded by the decoder 70 to produce a digital signal for a desired channel. The digital to analog converter 72 converts this digital signal to the analog signal necessary to drive the television set 20.

FIG. 5 shows an alternative antenna structure 80 embodying the principles of the invention. In this form of the invention, the antenna structure 80 includes two separate feed-horns, a satellite feed-horn 82 for receiving reflected signals from the satellite dish 84 and a terrestrial feed-horn 86 for receiving signals directly from the terrestrial transmitter 14 (FIG. 1). Both feed-horns 82 and 86 are preferably connected to a single LNB 88 which may have two integrally formed probes (not shown), each probe extending into one of the feed-horn wave guides. The terrestrial feed-horn 86 preferably is pivotally connected to the LNB 88 and satellite feed-horn 82 so that it may be rotated as shown at arrow B for alignment with its receiving end best positioned for receiving signals from the local terrestrial transmitter 14.

Those skilled in the art will readily appreciate that there are a number of antenna types that may be employed as the first and second antennas according to the invention. For example, a circular wave guide could be used as the antenna for receiving the local channel signals from the terrestrial transmitter 14 and another circular wave guide could be used in place of the feed-horn in the dish-type satellite antenna. Alternatively two "patch" or flat plate antennas could also be used for both receiving the satellite channel signals and the local channel signals. Even a single flat plate antenna could be used for receiving the satellite signals and the local terrestrially transmitted signals if the flat plate were mounted so that its orientation could be changed to receive the desired signal. In this single flat plate antenna form of the invention an antenna such as that disclosed in U.S. Pat. Nos. 4,761,654 or 5,005,019 with an integrally formed LNB would be mounted so that it could pivot upwardly in position to receive signals from the satellite and downwardly until it extends generally vertically to receive the terrestrially transmitted signals. Additionally the flat plate would be capable of pivoting about its base to face the best direction for receiving the desired signals. This single movable antenna structure is equivalent to the first and second antennas set out in the following claims.

The operation in the invention and the method for providing local channel signals with direct broadcast satellite signals may now be described with reference to FIGS. 1–5. Referring particularly to FIG. 1, the method includes transmitting converted local signals from the terrestrial transmitter 14 at a terrestrial transmitter location. The converted local channel signals are in a first frequency band that itself is within a satellite frequency band in which signals are transmitted from a direct broadcast satellite 12. The method also includes receiving both the converted local channel signals and the direct broadcast satellite channel signals at a user location remote from the terrestrial transmitter 14. The method continues with the step of combining the local channel signals and the direct broadcast satellite channel signals on a single propagation path for the final step of processing in the receiver 18 to produce the desired television channel signal.

In a practical application of the invention, the terrestrial transmitter 14 would preferably be operated by a local service provider that does not itself provide programming. The operator of the terrestrial transmitter would then obtain local programming from local broadcasters. In this preferred form of the invention the method also includes receiving the local channel signals in their regular or initial broadcast frequency and translating the local channel signals into converted local channel signals in the first frequency band. The conversion process would include converting the local channel signals from an analog to a digital form that is acceptable to the DBS receiver. The step of transmitting the local channel signals would then comprise retransmitting the converted local signals to direct broadcast system subscribers.

The method of combining the local channel signals and direct broadcast satellite channel signals may be performed with any suitable combiner. For example, the combiner may be a stripline combiner 44 as shown in FIG. 3 or a directional coupler as described above. In any event, the output is the combined signal which appears to the DBS receiver just as it would have appeared had the signal actually been broadcast from the satellite. Thus, the invention provides the advantage that no additional receiver is required to receive local channel signals and the local programming is seamlessly combined with the regional or national satellite programming.

The above described preferred embodiments are intended to illustrate the principles of the invention, but not to limit the scope of the invention. Various other embodiments and modifications to these preferred embodiments may be made by those skilled in the art without departing from the scope of the following claims.

I claim:

1. An apparatus for simultaneously providing local originating channels along with direct broadcast satellite television channels transmitted from a satellite, the apparatus comprising:

(a) a terrestrial transmitter located at a terrestrial broadcasting location for transmitting converted local channel signals in a first frequency band, the first frequency band contained within a satellite broadcast frequency band;

(b) a first antenna located at a user location remote from the terrestrial broadcasting location for receiving from the terrestrial transmitter the converted local channel signals in the first frequency band;

(c) a second antenna at the user location for receiving from the satellite direct broadcast satellite television channel signals in the satellite broadcast frequency band;

(d) combining means at the user location for combining the converted local channel signals received by the first antenna and the direct broadcast satellite television signals received by the second antenna to form combined television signals in the satellite broadcast frequency band on a single signal path; and

(e) signal processing means at the user location for receiving the combined television signals from the combining means and processing the combined television signals to produce a desired channel output signal.

2. The apparatus of claim 1 further comprising:

(a) a terrestrial receiver located at the terrestrial broadcasting location for receiving local channel signals; and

(b) a signal converter located at the terrestrial broadcasting location for converting the local channel signals to converted local channel signals in the first frequency band.

3. The apparatus of claim 1 wherein the first antenna is selected from the group consisting of circular waveguide antennas, feed-horn antennas, flat plate antennas, slot antennas, dipole antennas, and multi-dipole antennas.

4. The apparatus of claim 1 wherein the second antenna comprises:

(a) at least one reflector for reflecting and concentrating the direct broadcast satellite television channel signals;

(b) a signal collector for collecting the direct broadcast satellite television channel signals concentrated by the reflector; and

(c) an antenna probe extending into the signal collector for receiving the direct broadcast satellite television channel signals.

5. The apparatus of claim 4 wherein the signal collector is selected from the group consisting of feed-horn assemblies and circular wave guides.

6. The apparatus of claim 1 wherein the second antenna is a flat plate antenna.

7. The apparatus of claim 1 wherein the satellite broadcast frequency band has an approximate lower frequency limit of 12.2 Giga-Hertz and an approximate upper frequency limit of 12.7 Giga-Hertz.

8. The apparatus of claim 1 wherein the combining means comprises a stripline combiner mounted on a low noise block converter, the stripline combiner including:

(a) a first input connected to receive converted local channel signals from the first antenna;

(b) a second input connected to receive direct broadcast satellite television channel signals from the second antenna; and

(c) an output connected to deliver the combined television signals to signal processing elements of the low noise block converter.

9. An apparatus for simultaneously receiving signals from both a satellite source and a terrestrial source, the apparatus comprising:

(a) a first antenna for receiving from a terrestrial transmitter converted local channel signals in a first frequency band, the first frequency band contained within a satellite broadcast frequency band;

(b) a second antenna for receiving from the satellite source direct broadcast satellite television channel signals in the satellite broadcast frequency band; and

(c) combining means for combining the converted local channel signals received by the first antenna and the direct broadcast satellite television channel signals received by the second antenna to form combined television channel signals in the satellite broadcast frequency band on a single signal path.

10. The apparatus of claim 9 wherein the first antenna is selected from the group consisting of circular waveguide antennas, feed-horn antennas, flat plate antennas, slot antennas, dipole antennas, and multi-dipole antennas.

11. The apparatus of claim 9 wherein the second antenna comprises:

(a) at least one reflector for reflecting and concentrating the direct broadcast satellite television channel signals;

(b) a signal collector for collecting the direct broadcast satellite television channel signals concentrated by the reflector; and

(c) an antenna probe extending into the signal collector for receiving the satellite television channel signals.

12. The apparatus of claim 11 wherein the signal collector is selected from the group consisting of feed-horn assemblies and circular wave guides.

13. The apparatus of claim 9 wherein the second antenna is a flat plate antenna.

14. The apparatus of claim 9 wherein the satellite broadcast frequency band has an approximate lower frequency limit of 12.2 Giga-Hertz and an approximate upper frequency limit of 12.7 Giga-Hertz.

15. The apparatus of claim 9 wherein the combining means comprises a stripline combiner mounted on a low noise block converter, the stripline combiner including:

(a) a first input connected to receive converted local channel signals from the first antenna;

(b) a second input connected to receive direct broadcast satellite television channel signals from the second antenna; and

(c) an output connected to deliver the combined television channel signals to signal processing elements of the low noise block converter.

16. In a system for providing direct broadcast satellite television channels having a satellite transmitter for transmitting direct broadcast satellite television channel signals in a satellite broadcast frequency band, a satellite signal antenna for receiving direct broadcast satellite television channel signals at a user location, and signal processing means at the user location for receiving the direct broadcast satellite television channel signals and processing the signals to produce a desired channel output, the improvement comprising:

(a) a terrestrial transmitter for transmitting converted local channel signals in a first frequency band, the first frequency band contained within the satellite broadcast frequency band;

(b) a first antenna at the user location for receiving from the terrestrial transmitter the converted local channel signals in the first frequency band; and

(c) combining means at the user location for combining the converted local channel signals received by the first antenna and the direct broadcast satellite television signals received by the second antenna to form combined television signals in the satellite broadcast frequency band on a single signal path for processing by the signal processing means.

17. The system of claim 16 wherein the combining means comprises a stripline combiner mounted on a low noise block converter, the stripline combiner including:

(a) a first input connected to receive converted local channel signals from the first antenna;

(b) a second input connected to receive direct broadcast satellite television channel signals from the second antenna; and

(c) an output connected to deliver the combined television signals to signal processing elements of the low noise block converter.

18. A method for providing local originating channels along with direct broadcast satellite television channels transmitted from a satellite, the method comprising the steps of:

(a) transmitting converted local channel signals in a first frequency band from a terrestrial transmitter location, the first frequency band contained within a satellite broadcast frequency band;

(b) at a user location remote from the terrestrial transmitter location, receiving the converted local channel signals in the first frequency band;

(c) receiving at the user location direct broadcast satellite television channel signals in the satellite broadcast frequency band, the direct broadcast satellite television channel signals being transmitted from the satellite;

(d) combining the converted local channel signals and the direct broadcast satellite television signals to form combined television signals in the satellite broadcast frequency band on a single signal path; and

(e) processing the combined signals to produce a desired channel output signal.

19. The method of claim 18 further comprising the steps of:

(a) receiving at the terrestrial transmitter location local channel signals; and

(b) converting the local channel signals to converted local channel signals in the first frequency band.

20. The method of claim 18 wherein the step of combining the converted local channel signals and the direct broadcast satellite television signals to form the combined television signal is performed with a stripline combiner mounted on a low noise block converter and further including the step of:

(a) directing the combined television signals to signal processing elements of the low noise block converter.

21. An apparatus for simultaneously providing local originating channels, along with direct broadcast satellite television channels transmitted from a satellite, the apparatus comprising:

(a) a terrestrial transmitter located at a terrestrial broadcasting location for transmitting converted local channel signals in a first frequency band, the first frequency band contained within a satellite broadcast frequency band;

(b) an antenna located at a user location remote from the terrestrial broadcasting location for receiving from the terrestrial transmitter the converted local channel signals in the first frequency band when the antenna is oriented in a first position and for receiving from the satellite direct broadcast satellite television channel signals in the satellite broadcast frequency band when oriented in a second position;

(c) antenna orienting means connected to the antenna for enabling the antenna to move between the first position and the second position; and

(d) signal processing means at the user location for receiving television signals from the antenna and processing the television signals to produce a desired channel output signal.

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FCC MAKES SPECTRUM AVAILABLE FOR NEW FIXED SATELLITE SERVICES AT KU-BAND; SEEKS COMMENT ON LICENSING NEW FIXED SERVICE AT 12 GHz

Washington, DC -- The Commission yesterday adopted a *First Report and Order (First R&O)* to permit non-geostationary satellite orbit (NGSO) fixed-satellite service (FSS) providers to operate in various segments of the Ku-band, and adopted rules and policies to govern these operations. NGSO FSS can provide a variety of new services to the public, such as high-speed Internet access, plus other types of high-speed data, video and telephony services. Because of its ability to serve large portions of the earth's surface, NGSO FSS can bring advanced services to rural areas. The Commission also adopted technical criteria so that NGSO FSS operations can share spectrum with incumbent services on a co-primary basis without causing unacceptable interference to them and without unduly constraining future growth of incumbent services or NGSO FSS system flexibility.

In the *First R&O*, the Commission concluded that a new terrestrial fixed Multichannel Video Distribution and Data Service (MVDDS) can operate in the 12.2-12.7 GHz band on a non-harmful interference basis with incumbent Broadcasting Satellite Services (BSS) and on a co-primary basis with the NGSO FSS. The Commission also adopted a *Further Notice of Proposed Rulemaking (Further NPRM)* seeking comment on technical and service rules for licensing the MVDDS. MVDDS could be used to deliver a wide array of video programming, including local television, and data services in both urban and rural areas.

The Commission's actions provide for the introduction of new advanced services to the public, consistent with our obligations under section 706 of the 1996 Telecommunications Act, and promote increased competition among satellite and terrestrial services. The Commission's actions also comply with the *Rural Local Television Signals Act,* federal legislation adopted last year as part of the 1999 *Satellite Home Viewer Improvement Act (SHVIA).* Among other things, this law requires the Commission to make a determination by November 29, 2000, regarding licenses or other authorizations for facilities that will utilize, for delivering local broadcast television signals to satellite television subscribers in unserved or underserved local television markets, spectrum otherwise allocated to commercial use.

The Commission's action to provide spectrum for NGSO FSS operations was taken in response to a petition for rulemaking filed by SkyBridge L.L.C. (SkyBridge). The Commission's decisions in the *First R&O* were promoted by actions taken at the 1997 World Radiocommunication Conference (WRC-97) which permitted NGSO FSS operations in various segments of the Ku-band and the 2000 World Radiocommunication Conference (WRC-2000) which reached consensus on technical sharing criteria between NGSO FSS and incumbent fixed satellite and fixed terrestrial operations.

The *First R&O* made the following major determinations regarding NGSO FSS:

- Permits NGSO FSS gateway earth stations to provide, on a primary basis, downlink (space-to-Earth) operations in the 10.7-11.7 GHz band and uplink (Earth-to-space) operations in the 12.75-13.15 GHz, 13.2125-13.25 GHz, and 13.75-14.0 GHz bands, thereby providing 1000 megahertz of spectrum for gateway downlink and 687.5 megahertz of spectrum for gateway uplink operations. Further, permits gateway earth stations to operate in the 11.7-12.7 GHz downlink and 14.0-14.5 GHz uplink bands that will be predominantly used by NGSO FSS service links.
- Permits NGSO FSS to operate service downlinks (space-to-Earth) in the 11.7-12.2 GHz band on a primary basis, and allocate the 12.2-12.7 GHz band for service downlinks on a primary basis. Permits NGSO FSS to operate service uplinks (Earth-to-space) in the 14.0-14.5 GHz band. Provides 1000 megahertz of spectrum for service downlink and 500 megahertz of spectrum for service uplink operations.
- Adopts technical sharing criteria (power flux density (PFD) limits) for NGSO FSS and FS operations in the 10.7-11.7 GHz band. Adopts technical sharing criteria (equivalent power flux density (EPFD) uplink and downlink limits) for NGSO FSS and geostationary-satellite orbit (GSO) FSS operations in all bands.

In the *First R&O*, the Commission also concluded that a new fixed terrestrial service, MVDDS, can operate in the 12.2-12.7 GHz band under the existing fixed service allocation, *i.e.*, on a non-harmful interference basis to incumbent Broadcasting Satellite Service (BSS), and on a co-primary basis to the new NGSO FSS. The Commission determined that it could establish technical criteria for MVDDS that would not impair the provision of BSS.

In the *Further NPRM*, the Commission proposes to authorize MVDDS in the 12.2-12.7 GHz band. The Commission seeks comment on various technical and service issues concerning authorizing MVDDS in the band, including the issues described below.

- Technical sharing criteria between the MVDDS and BSS and between the MVDDS and NGSO FSS.
- Service areas and frequency assignments.
- Permissible operations, eligibility requirements and regulatory status of MVDDS, and other service technical and licensing rules under Part 101 of the Commission's rules.
- Disposition of pending applications filed by Broadwave USA, PDC Broadband Corporation, and Satellite Receivers, Ltd..
- Use of the general competitive bidding rules set forth in Part 1, Subpart Q, of the Commission's rules in the event an auction is conducted.

Action by the Commission November 29, 2000, by *First Report and Order/Further Notice of Proposed Rulemaking* (FCC 00-418). Chairman Kennard, Commissioners Ness, Powell and Tristani, with Commissioner Furchtgott-Roth approving in part and dissenting in part, and Commissioners Furchtgott-Roth and Tristani issuing separate statements.

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